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Health-related Microbial Quality of Drinking Water in Kangavar, Western Iran

Nezam Mirzaei[1,2], Heshmatollah Nourmoradi[3], Allahbakhsh Javid[4], Fazel Mohammadi-Moghadam[5], Hamid Reza Ghaffari[6], Mohammad Ahmadpour[7] and Kiomars Sharafi[8,2*]

[1]Environmental Health Research Center, Kurdistan University of Medical Sciences, Sanandaj, Iran.
[2]Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.
[3]Department of Environmental Health Engineering, School of Health, Ilam University of Medical Sciences, Ilam, Iran.
[4]School of Public Health, Shahroud University of Medical Sciences, Shahroud, Iran.
[5]Department of Environmental Health Engineering, School of Health, Shahrekord University of Medical Sciences, Shahrekord, Iran.
[6]Social Determinants in Health Promotion Research Center, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.
[7]Department of Public Health, Maragheh University of Medical Sciences, Maragheh, Iran.
[8]Department of Environmental Health Engineering, School of Public Health, Kermanshah University of Medical Sciences, Kermanshah, Iran.

Authors' contributions

This work was carried out in collaboration between all authors. Authors KS and NM designed the study, wrote the proposal and wrote the first draft of the manuscript. Authors HN, AJ and FMM collected the data and imported them to SPSS software. Authors HRG and MA also managed the literature searches. All authors read and approved the final manuscript.

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**Corresponding author: E-mail: kio.sharafi@gmail.com;*

ABSTRACT

Evaluation of the microbial quality of drinking water can prevent the water-borne diseases outbreak that is one of the most important challenges in the world. Therefore, the aim of this study was to assess the seasonal variation of water-borne diseases prevalence associated with the microbial quality of drinking water and the comparison between rural and urban areas in Kangavar city, west of Iran. To accomplish this study, the results of the microbial quality of drinking water and cases of simple diarrhea, dysentery, typhoid and hepatitis A were received from all rural and urban health centers of the city during five years (2006-2010). To determine the relationship between diseases and microbial quality of water, Correlation instruction and Pearson correlation coefficient were used. The results showed that except hepatitis A, the incidence of all diseases in different areas (urban or rural) and seasons had significant relationship with microbial contamination of drinking water (P-value<0.05). The stronger relationship was observed in rural areas than in urban areas (except simple diarrhea) and in warm seasons than in cold seasons. With respect to the impact of the microbial quality of water on the incidence of dysentery and typhoid diseases, keeping up the quality of drinking water in places and times with high sensitivity (rural areas and warm seasons) should be considered strongly.

Keywords: Drinking water; disease; microbial quality; Kangavar.

1. INTRODUCTION

Drinking water resources containing pathogenic microorganisms can cause water-borne diseases among the consumers [1-3]. Overall, microbial contamination risk of drinking water is related to fecal contamination as a result of discharging sewage to water resources [4,5]. According to the World Health Organization (WHO) in 2008, the mortality rate associated with water-borne diseases was more than 5 million people a year [6]. The cases of diarrhea caused by contaminated drinking water estimated to be 15-20% of water-borne diseases. Therefore, due to the low levels of sanitation and unsafe water resources, children especially in rural communities of developing countries are at risk from water-borne diseases. Annually, about 1.6 million children (less than 5 years old) die due to water-borne diseases which 84% of them live in rural areas. It has been estimated that 1.7 billion rural residents do not access to safe drinking water and appropriate sanitation levels in 2015 [7,8]. Considering that drinking water should not contain unacceptable levels of hazardous chemicals and infectious risk to the health (those caused by fecal contamination) [9,10]. Evaluation of microbial quality of drinking water can protect consumers from illnesses transmitted due to the consumption of water containing pathogens such as bacteria, viruses and protozoa. It can prevent the water-borne diseases outbreak that is one of the most important challenges nowadays [11-13]. Therefore, this study was designed to determine the prevalence of water-borne diseases and its relation to drinking water microbial quality as well as comparison between rural and urban areas of Kangavar County in the west of Iran.

2. MATERIALS AND METHODS

Kangavar County with coordinated of 34°29'N and 47°56'E is located in the west of Iran (Fig. 1) and it has a population of 79,690 people (50,150 and 29,540 people dwell in urban and rural, respectively). The total number of households in the county is 19,715 (12,256 and 7,459 of them live in urban and rural area). This county consists of one city of Kangavar City and many villages. Water supplies of the Kangavar City include 11 wells that five wells are located in Suleiman Abad village and other wells are located in Ali Abad village.

Drinking water in the rural area of this county is provided by wells (manual, semi-deep and deep) and springs. The material of water distribution system pipes is galvanized iron, austenite, PE, asbestos and JPR constructed. The average water consumption per capita is 170 lpcd. In this study, the results of the microbial quality of drinking water and the cases numbers of diarrhea, dysentery, typhoid and hepatitis-A were provided from the rural and urban health centers of the county during five years (2006-2010). The data were analyzed by SPSS-16 software. Thus, Frequency and Crosstab instructions were used to describe the data and correlation instruction and Pearson correlation coefficient were also applied to determine the relationship between disease and microbial quality of water were used. Then, the prevalence (Eq. 1) of the water-borne diseases was measured for this county.

$$\text{Prevalence (in 1000 person)} = \frac{\text{Number of existing cases in specific date}}{\text{Number of population in that date}} \quad (1)$$

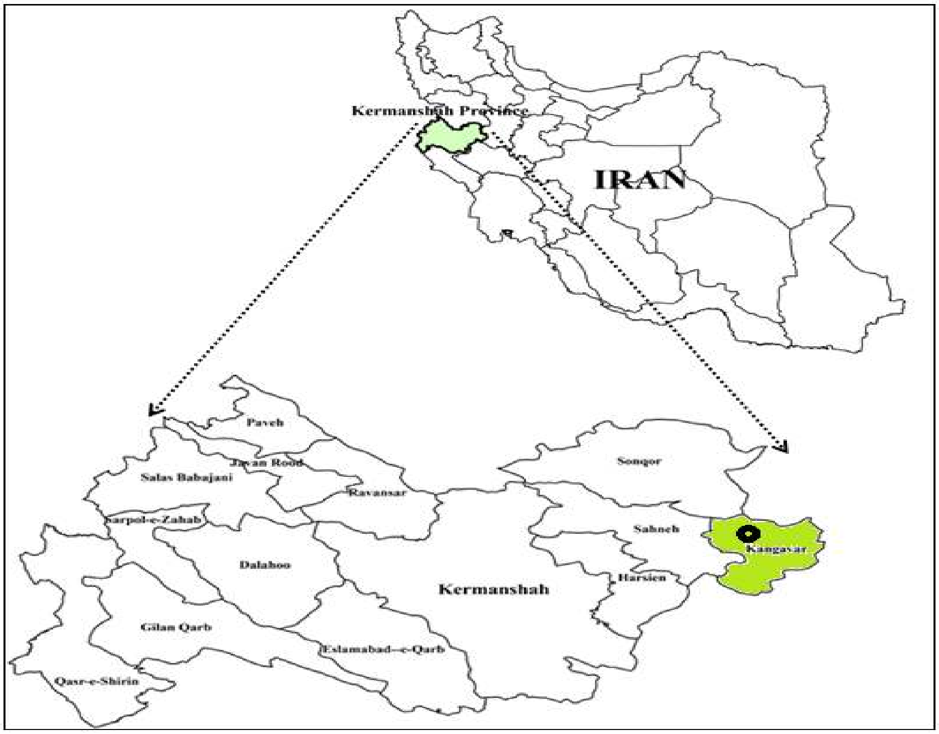

Fig. 1. Location of Kangavar County in Iran

3. RESULTS

Obtained results indicated that the average desirability of microbial quality of drinking water did not differ significant (P-value>0.05) in considered years, but there were significant difference between urban and rural areas, health centers and seasons (P-value<0.05). Furthermore, the results revealed that the highest and lowest Point Prevalence of simple diarrhea has been recorded in rural health center of Hassan Abad and urban health center 1, respectively. The highest Point Prevalence of dysentery was observed in rural health center 2 and the lowest rate was observed in rural health center 1. Urban health center 2 and urban health center 1 had the highest and lowest Point Prevalence of typhoid, respectively. The highest and lowest Point Prevalence of studied diseases were observed in summer and winter, respectively. For all diseases, Point Prevalence in rural areas was more than in urban areas (Table 2). Point Prevalence of hepatitis was zero during the study period. Other results of the average desirability of drinking water microbial quality and Point Prevalence of diseases in Kangavar city during 5 years (2006-2010) are presented in Tables 1 and 2, respectively. The relationship between the prevalence of all diseases (except hepatitis) and microbial contamination of drinking water in different regions (urban or rural) and seasons were significant (P-value<0.05) (Table 3).

4. DISCUSSION

The results showed that the mean desirability of microbial quality of drinking water in Kangavar City was not significantly different among studied years, but differences were significant among seasons. This indicated that the microbial quality of water can be influenced by temperature and atmospheric conditions (precipitation) [14]. Since the seasons of the year will repeat next year, there is no significant difference over several years. The results also showed that the highest and lowest desirability of the microbial quality of water were observed in winter and summer, respectively. Low microbial quality of water in summer can be because of increasing of per capita consumption, decreasing of the discharge of water resources, increasing of pathogens in water supplies, remaining of water in pipes providing the growth of microorganisms and suitable warm weather for the growth of microorganisms in water. The arrangement of the desirability of microbial quality from the highest to the lowest for different seasons is as summer <spring <autumn <winter. These results are confirmed by other studies such as Bradd study [14] on the microbial quality of water in villages of Georgiaand, Oguntoke [15] about the relationship between water quality and water-borne diseases in Ibadan city, Nigeria and Mahvi [16] on the microbial quality of water in villages of Qazvin province. These studies reported the lowest microbial quality of water in summer. However, some other studies reported

Table 1. Average number of microbial quality of drinking water in terms of fecal coliform

Variable		Number of cases	Average ±SD	Min	Max	P
Year	2006	599	93.2±13.2	40	100	
	2007	840	93.2±13.9	25	100	
	2008	760	90.0±14.8	50	100	0.249
	2009	690	90.0±16.4	33	100	
	2010	726	92.3±12.2	55	100	
Season	Spring	848	91.2±13.9	40	100	
	Summer	972	87.7±16.8	33	100	<0.001
	Autumn	880	93.1±12.8	33	100	
	Winter	915	95.6±11.4	25	100	
Health center	*UH-1	400	99.0±2.7	90	100	
	**RH-1	250	91.1±17.4	25	100	
	*UH-2	455	100.0±0.0	100	100	
	**RH-2	350	92.7±15.3	33	100	
	*UH-Hassan Abad	350	93.5±13.6	45	100	<0.001
	**RH-Hassan Abad	400	86.3±13.7	55	100	
	**RH-Godin	450	89.7±16.3	42	100	
	**RH-Fash	500	86.9±14.0	55	100	
	**RH-Dehlor	460	87.8±15.8	40	100	
Area	Urban	1205	97.5±8.5	45	100	<0.001
	Rural	2410	89.1±15.5	25	100	
Overall		3615	91.9±14.1	25	100	-

**UH= Urban Health center, **RH= Rural Health Center*

Table 2. Prevalence of the diseases (in 1000 person) during five years (2006-2010)

Variable		Disease			
		Diarrhea	Dysentery	Typhoid	Hepatitis-A
Health centers	UH-1	7.40	0.39	0.20	0
	RH-1	23.40	1.87	1.90	0
	UH-2	20.10	1.49	4.50	0
	RH-2	11.40	0.07	2.20	0
	UH-Hassan Abad	67.70	1.00	0.80	0
	RH-Hassan Abad	112.40	0.62	2.20	0
	RH-Godin	19.90	0.57	0.90	0
	RH-Fash	12.40	1.06	1.90	0
	RH-Dehlor	33.60	0.63	1.50	0
Seasons	Spring	5.90	0.16	0.27	0
	Summer	13.10	0.25	0.49	0
	Autumn	5.80	0.19	0.27	0
	Winter	3.45	0.16	0.16	0
Location	Urban	9.22	0.40	0.40	0
	Rural	29.66	0.83	1.53	0
Overall		28.10	0.77	1.20	0

**UH= Urban Health center, **RH= Rural Health Center*

Table 3. Pearson correlation coefficient and P-value of water-borne diseases

Variable		PCC and P-value of all type of diseases with microbial quality of drinking water							
		Diarrhea		Dysentery		Typhoid		Hepatitis-A	
		*PCC	P-value	*PCC	P-value	*PCC	P-value	*PCC	P-value
Area	Urban	-0.871	0.001	-0.266	0.001	-0.290	0.001	0.066	0.375
	Rural	-0.379	0.001	-0.292	0.001	-0.407	0.001	-0.014	0.791
Season	Spring	-0.433	0.001	-0.319	0.021	-0.418	0.001	-0.019	0.658
	Summer	-0.545	0.001	-0.393	0.001	-0.536	0.001	-0.019	0.700
	Autumn	-0.386	0.008	-0.193	0.211	-0.338	0.004	0.000	0.705
	Winter	-0.229	0.001	-0.108	0.001	-0.248	0.001	0.033	0.625
Overall		-0.541	0.001	-0.261	0.001	-0.394	0.001	-0.021	0.625

**PCC=Pearson Correlation Coefficient*

undesirable microbial quality in cold seasons due to the rain and flooding, deficit of health facilities, environmental factors, inappropriate water resources and old water transmission and distribution system, improper drainage of passages and lack of wastewater collection system [4,17-19]. But in this study because of using of springs as a source of water supply in most rural areas, the rate of water-borne disease is depend on the season and proper conditions for the growth of pathogens at higher temperatures. Microbial contamination was found to be more in warm seasons. Also, the results showed significant differences between the mean desirability of drinking water microbial quality in urban and rural areas. Therefore, the quality of drinking water in urban health centers was more desirable than in rural health centers. A field study carried out on the resources of urban and rural water and transmission-distribution systems of urban and rural water showed that the proximity of rural water sources (wells and spring), pollution of transmission-distribution systems with animal waste, sewage and garbage, low improvement index of bathroom and toilet (unsanitary sewage disposal in pathways), pipe breakage due to corrosion and long track, agricultural activities such as vegetating, disregard of personal and food hygiene, the lack of regular and continuous chlorination, lack of water treatment facilities cause the lower desirability of microbial quality of water in rural than in urban areas. This was confirmed by other researchers such as Tumwine et al. [20], they showed that sewage discharge as unsanitary reduced the microbial quality of drinking water in East Africa villages. The study of Sadeghi et al. [21] represented that 23% of rural water resources of Iran had microbial contamination due to the high turbidity. The study of Bessong et al. [22] on the incidence of diarrhea in rural communities of South Africa also showed a significant relationship between the type of rural water resources (springs, wells, etc) and microbial quality, as the microbial contamination in surface resources was more than in groundwater resources. The study of Yassin et al. [4] in assessing the microbial quality of water resources in Gaza Strip, indicated that with regard to water supply, transmission line length, distribution network extent, the lifetime of the piping network, disinfection system, proximity to pollutant sources including sewage collection system and animal waste are different in urban and rural areas. Therefore, the microbial quality of water also varies accordingly. The results showed that with the exception of hepatitis, there is a significant relationship between the disease type (simple diarrhea, dysentery and typhoid) and season and area of residence (urban or rural) (P-value<0.05). Therefore, the most prevalence of these diseases occurred in summer and in rural areas. It can be due to the low desirability level of microbial quality in summer and in rural areas, so it is expected that the incidence of these diseases is high [6,23]. However, Pearson correlation coefficient of simple diarrhea with microbial contamination of drinking water in rural area was less than in urban area. This indicates that microbial contamination of drinking water in rural areas has played a less important role in the incidence of simple diarrhea and the outbreak of it in rural areas can be related to other reasons such as contaminated food, poor personal hygiene and other similar factors. But high Pearson correlation coefficient of other diseases (dysentery and typhoid) with microbial contamination of drinking water in rural areas was higher than in urban areas. The results showed that the amount of Pearson correlation coefficient of disease type (simple diarrhea, dysentery and typhoid) with microbial contamination of water from the highest to the lowest in different seasons was as winter< autumn< spring < summer. Since the microbial quality of drinking water and food is affected by ambient temperature [6,14,16,18]. Thus, with increasing of the ambient temperature, the desirability of microbial quality of water and food reduces, so its Pearson correlation coefficient with disease type (simple diarrhea, dysentery and typhoid) increases [24,25]. These results are consistent with studies from other researchers, as the study of Mahvi and Karyab [16] demonstrated that the prevalence of diarrhea in villages with safe and contaminated water was 5.3% and 8.3%, respectively. The study of Bessong et al. [22] also showed the outbreak of water-borne diseases caused by microorganisms such as cholera, salmonella and shigella in rural communities of Tshikuwi in South Africa due to undesirability of water quality. Furthermore, the study of Bradd et al. [14] showed that 79.2% of water samples from villages of Georgia were contaminated by Salmonella and the prevalence in summer was more than in other seasons.

5. CONCLUSION

According to the results, it can be concluded that the microbial quality of drinking water in term of causing of dysentery and typhoid diseases is more effective in rural than in urban areas. Regarding the prevalence of simple diarrhea, it is more effective in warm seasons than in cold seasons. Therefore, keeping up the quality of drinking water in places and times with high sensitivity (rural areas and warm seasons) in term of water-borne diseases should be given special attention.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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